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## CLAIMS

2 WHAT IS CLAIMED IS:

3 1. An earth boring bit comprising:

4 a) a bit body having a longitudinal bit axis and a bit diameter;

5 b) at least one rolling cone cutter rotatably mounted on the bit body and having an

6 offset of its rotational axis from the bit axis of:

1) at least  $1/8$  inch when the bit diameter is less than 4 inches,

2) at least  $5/32$  inches when the bit diameter is 4 inches or greater and less than 5  
inches,

3) at least  $\frac{1}{4}$  inches when the bit diameter is 5 inches or greater and less than 7  
inches,

4) at least  $11/32$  inches when the bit diameter is 7 inches or greater and less than 9  
inches,

5) at least  $13/32$  inches when the bit diameter is 9 inches or greater and less than 12  
inches,

15 6) at least  $7/16$  inches when the bit diameter is 12 inches or greater and less than 16  
inches, and

16 7) at least  $17/32$  inches when the bit diameter is at least 16 inches; and

17 c) at least one super-abrasive cutter element located on the rolling cone cutter and

18 extending to full gage diameter.

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20 22 2. The bit of claim 1 wherein the amount of offset is:

- 1        a) at least 5/32 inches and less than 3/16 inches when the bit diameter is less than 4 inches,
- 2        b) at least 3/16 inches and less than 1/4 inches when the bit diameter is at least 4 inches and  
3                      less than 5 inches,
- 4        c) at least 9/32 inches and less than 5/16 inches when the bit diameter is at least 5 inches  
5                      and less than 7 inches,
- 6        d) at least 3/8 inches and less than 7/16 inches when the bit diameter is at least 7 inches  
-                      and less than 9 inches,
- 7        e) at least 15/32 inches and less than 9/16 inches when the bit diameter is at least 9 inches  
8                      and less than 12 inches,
- 9        f) at least 19/32 inches and less than 1/4 inches when the bit diameter is at least 12 inches  
10                      and less than 16 inches, and
- 11        g) at least 3/4 inches and less than 1 inch when the bit diameter is at least 16 inches.

12. The bit of claim 1 wherein the amount of offset is:

- 13        a) at least 3/16 inches when the bit diameter is less than 4 inches,
- 14        b) at least 1/4 inches when the bit diameter is at least 4 inches and less than 5 inches,
- 15        c) at least 5/16 inches when the bit diameter is at least 5 inches and less than 7 inches,
- 16        d) at least 7/16 inches when the bit diameter is at least 7 inches and less than 9 inches,
- 17        e) at least 9/16 inches when the bit diameter is at least 9 inches and less than 12 inches,
- 18        f) at least 3/4 inches when the bit diameter is at least 12 inches and less than 16 inches, and
- 19        g) at least 1 inch when the bit diameter is at least 16 inches.

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1       4.     The bit of claim 1 wherein the super-abrasive cutter element comprises a polycrystalline  
2     diamond coated insert.

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4       5.     The bit of claim 1 wherein the super-abrasive cutter element comprises a cubic boron nitride  
5     coated insert.

6

6.     The bit of claim 1 wherein the super-abrasive cutter element is located on the gage row of  
the cone cutter.

7.     The bit of claim 1 wherein the super-abrasive cutter element is located on a secondary gage  
row of the cone cutter.

8.     The bit of claim 1 wherein the super-abrasive cutter element is located on a heel row of  
the cone cutter.

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16     9.     The bit of claim 1 wherein the cone cutter has a journal angle of about  $33^\circ$  or less.

17

18     10.    The bit of claim 1 wherein the bit is a soft to medium-hard formation insert bit.

19

20     11.    The bit of claim 10 wherein the bit has an IADC classification of 6-2-x or lower series  
21     number.

22

1       12. The bit of claim 11 wherein the bit has an IADC classification of 4-4-x or lower series  
2       number.

3

4       13. The bit of claim 1 wherein the bit is a milled tooth bit.

5

6       14. The bit of claim 13 wherein the bit has an IADC classification of 2-3-x or lower series  
7       number.

15. The bit of claim 14 wherein the bit has a IADC classification of 1-3-x or lower series  
number.

16. The bit of claim 1 further comprising a super-abrasive cutter element located on an off-gage  
row of the cone cutter.

15      17. The bit of claim 1 further comprising a super-abrasive cutter element located on an inner  
16      row of the cone cutter.

17

18      18. The bit of claim 1 wherein there are three rolling cone cutters, each of which is offset.

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20      19. The bit of claim 18 wherein each of the three cone cutters has substantially the same  
21      amount of offset.

22

1       20.     The bit of claim 1 wherein there are super-abrasive cutter inserts located on both a gage row  
2       and a heel row of the rolling cone cutter.

3

4       21.     An earth boring bit comprising:

5           a)     a bit body having a longitudinal bit axis and a bit diameter;  
6           b)     at least one rolling cone cutter rotatably mounted on the bit body and having an  
7       offset of its rotational axis from the bit axis of:

- 1           1) at least 1/8 inch when the bit diameter is less than 4 inches,
  - 2           2) at least 5/32 inches when the bit diameter is 4 inches or greater and less than 5  
inches,
  - 3           3) at least 1/4 inches when the bit diameter is 5 inches or greater and less than 7  
inches,
  - 4           4) at least 11/32 inches when the bit diameter is 7 inches or greater and less than 9  
inches,
  - 5           5) at least 13/32 inches when the bit diameter is 9 inches or greater and less than 12  
inches,
  - 6           6) at least 7/16 inches when the bit diameter is 12 inches or greater and less than 16  
inches, and
  - 7           7) at least 17/32 inches when the bit diameter is at least 16 inches; and
- 20           c)     at least one super-abrasive cutter element located on the cone cutter.

21

22       22.     The bit of claim 21 wherein the amount of offset is:

- 1       a) at least 5/32 inches and less than 3/16 inches when the bit diameter is less than 4 inches,
- 2       b) at least 3/16 inches and less than 1/4 inches when the bit diameter is at least 4 inches and
- 3              less than 5 inches,
- 4       c) at least 9/32 inches and less than 5/16 inches when the bit diameter is at least 5 inches
- 5              and less than 7 inches,
- 6       d) at least 3/8 inches and less than 7/16 inches when the bit diameter is at least 7 inches
- 7              and less than 9 inches,
- 8       e) at least 15/32 inches and less than 9/16 inches when the bit diameter is at least 9 inches
- 9              and less than 12 inches,
- 10      f) at least 19/32 inches and less than 3/4 inches when the bit diameter is at least 12 inches
- 11              and less than 16 inches, and
- 12      g) at least 3/4 inches and less than 1 inch when the bit diameter is at least 16 inches.

23. The bit of claim 21 wherein the amount of offset is:

- 15      a) at least 3/16 inches when the bit diameter is less than 4 inches,
- 16      b) at least 1/4 inches when the bit diameter is at least 4 inches and less than 5 inches,
- 17      c) at least 5/16 inches when the bit diameter is at least 5 inches and less than 7 inches,
- 18      d) at least 7/16 inches when the bit diameter is at least 7 inches and less than 9 inches,
- 19      e) at least 9/16 inches when the bit diameter is at least 9 inches and less than 12 inches,
- 20      f) at least 3/4 inches when the bit diameter is at least 12 inches and less than 16 inches, and
- 21      g) at least 1 inch when the bit diameter is at least 16 inches.

22

1       24. The bit of claim 21 wherein the super-abrasive cutter element extends at least to near gage  
2 diameter.

3

4       25. The bit of claim 21 wherein the super-abrasive cutter element is located on an inner row of  
5 the rolling cone cutter.

6

26. The bit of claim 25 wherein the super-abrasive cutter element comprises a polycrystalline  
diamond coated insert.

27. The bit of claim 21 wherein the super-abrasive cutter element extends to substantially full  
gage diameter.

28. The bit of claim 22 wherein the super-abrasive cutter element comprises a polycrystalline  
diamond coated insert.

15

16       29. The bit of claim 23 wherein the super-abrasive cutter element comprises a polycrystalline  
17 diamond coated insert.

18

19       30. A hard to extremely hard formation-type earth boring bit having an IADC numeric  
20 nomenclature of 6-3-x or higher and comprising:

- 21           a)      a bit body having a longitudinal bit axis and a bit diameter;  
22           b)      at least one rolling cone cutter rotatably mounted on the bit body and having an

- 1 offset of its rotational axis from the bit axis of:
- 2       1) at least 1/16 inches when the bit diameter is less than 7 inches,
- 3       2) at least 3/32 inches when the bit diameter is at least 7 inches and less than 12
- 4                  inches,
- 5       3) at least 5/32 inches when the bit diameter is at least 12 inches; and
- 6       c) at least one super-abrasive cutter element located on the cone cutter.

31. The bit of claim 30 wherein the super-abrasive cutter element is located on an inner row of the rolling cone cutter.

32. The bit of claim 30 wherein the super-abrasive cutter element extends to at least near gage diameter.

33. The bit of claim 32 wherein the super-abrasive cutter element comprises a polycrystalline diamond coated insert.

34. The bit of claim 30 wherein the amount of offset is:

- a) at least 3/32 inches and less than 1/8 inches when the bit diameter is less than 7 inches,
- b) at least 5/32 inches and less than 7/32 inches when the bit diameter is at least 7 inches and less than 12 inches, and
- c) at least 7/32 inches and less than 9/32 inches when the bit diameter is at least 12

1    ~~inches.~~

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3    35.   The bit of claim 34 wherein the super-abrasive cutter element comprises a polycrystalline  
4    diamond coated insert.

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6    36.   The bit of claim 30 wherein the amount of offset is:

- 7       a)   at least 1/8 inches when the bit diameter is less than 7 inches,
- b)   at least 7/32 inches when the bit diameter is at least 7 inches and less than 12 inches,  
            and
- c)   at least 9/32 inches when the bit diameter is at least 12 inches.

1    37.   The bit of claim 36 wherein the super-abrasive cutter element comprises a polycrystalline  
2    diamond coated insert.

15    38.   The bit of claim 30 wherein ~~the cone cutter has a journal angle of about 36° or more.~~

16

17    39.   The bit of claim 32 wherein the super-abrasive cutter element is located on a gage row of  
18    the rolling cone cutter.

19

20    40.   The bit of claim 32 wherein the super-abrasive cutter element is located on a secondary  
21    ~~gage row of the rolling cone cutter.~~

22

1       41. The bit of claim 32 wherein the super-abrasive cutter element is located on a heel row of the  
2       rolling cone cutter.

3

4       42. The bit of claim 39 further comprising a super-abrasive cutter element located on the inner  
5       row of the rolling cone cutter.

6

7       43. The bit of claim 30 wherein the super-abrasive cutter element comprises a cubic boron  
8       nitride coated insert.

9

10      44. A medium-hard to extremely hard formation-type earth boring bit comprising:  
11           a) a bit body having a longitudinal bit axis and a bit diameter;  
12           b) at least one rolling cone cutter rotatably mounted on the bit body and having an  
13       offset of its rotational axis from the bit axis of:  
14            4) at least 1/16 inches when the bit diameter is less than 7 inches,  
15            5) at least 3/32 inches when the bit diameter is at least 7 inches and less than 12  
16            inches,  
17            6) at least 5/32 inches when the bit diameter is at least 12 inches; and  
18           c) a journal angle being formed between the rotational axis and the bit axis of at least  
19            36°;  
20           d) at least one super-abrasive cutter element located on an inner row of the cone cutter.

21      2

22      2       45. The bit of claim 44 wherein the super-abrasive cutter element comprises a polycrystalline

1      diamond coated insert.

2      3

3      46.    The bit of claim 44 wherein the super-abrasive cutter element comprises a cubic boron  
4      nitride coated insert.

5

*Sub  
A2  
7*

47.    The bit of claim 44 wherein the amount of offset is:

- a)      at least 3/32 inches and less than 1/8 inches when the bit diameter is less than 7 inches,
- b)      at least 5/32 inches and less than 7/32 inches when the bit diameter is at least 7 inches and less than 12 inches, and
- c)      at least 7/32 inches and less than 9/32 inches when the bit diameter is at least 12 inches.

48.    The bit of claim 44 wherein the amount of offset is:

- a)      at least 1/8 inches when the bit diameter is less than 7 inches,
- b)      at least 7/32 inches when the bit diameter is at least 7 inches and less than 12 inches, and
- c)      at least 9/32 inches when the bit diameter is at least 12 inches.

*6*

19  
20    49.    The bit of claim 44 wherein the bit comprises an insert bit having an IADC classification of  
21    6-l-x or higher series number.

22

1      30. The bit of claim ~~44~~ further comprising a super-abrasive cutter element located on a gage  
2      row of the rolling cone cutter.

3      31. The bit of claim ~~44~~ further comprising a super-abrasive cutter element located on a  
4      secondary gage row of the rolling cone cutter.  
5

6      32. The bit of claim ~~44~~ further comprising a super-abrasive cutter element located on a heel row  
of the rolling cone cutter.

10      33. The bit of claim ~~44~~ further comprising super-abrasive cutter elements located on all the  
inner rows of all the rolling cone cutters.